# A short-term groundwater survey at the Olentangy River Wetland Research Park

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## Introduction

The knowledge of groundwater flows and groundwater quality is essential for the understanding of processes in and around wetlands. Changing geological conditions within the catchment area, varying biological activity and fluctuating meteorological influences are among the reasons chemical and physical parameters in groundwater undergo changes.

During a three-week study the author tried to analyze the development of the groundwater surface and the spatial distribution of its chemical parameters and physical properties. In order to get a holistic view of groundwater, long-term measurements would be needed. The results and methods developed in this study might be useful as a basis for further research.

## Methods

### *Field study*

Each well located at the Olentangy River Wetland Research Park (Columbus, Ohio, USA; Fig. 1) was sampled on-site for the following parameters: groundwater level, conductivity, temperature, pH, redox potential and dissolved oxygen. An overview of measured wells and staff gauges is

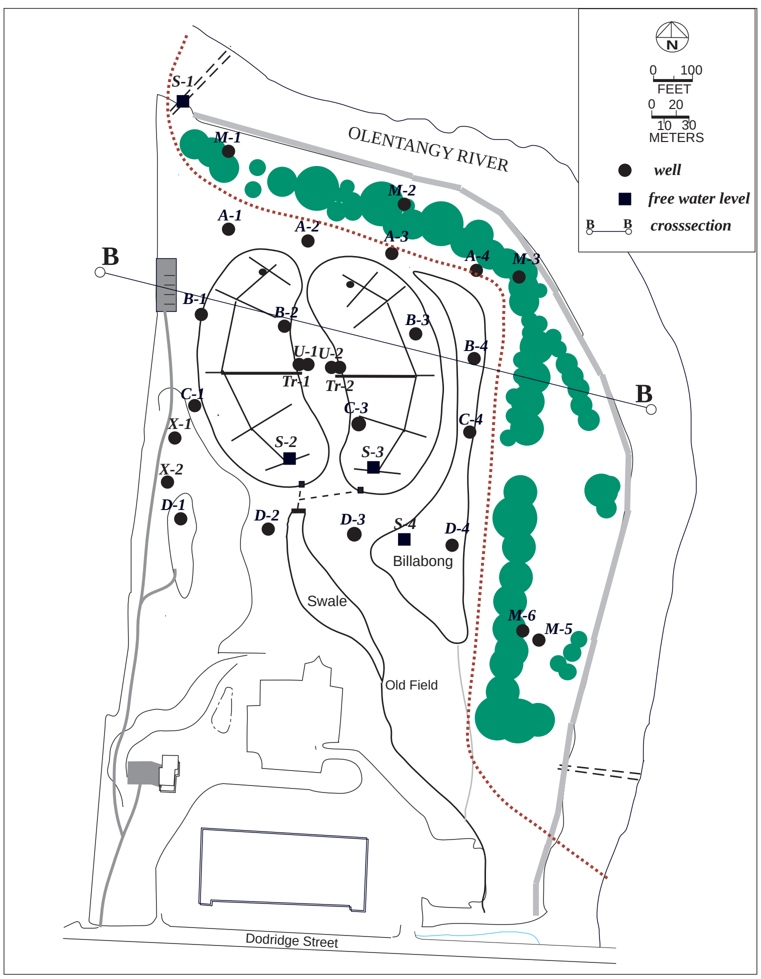



Figure 1. Survey area showing the sampled wells, staff gages and the location of a cross-section

given in Figure 1.

On June 24, 1998 a set of complete groundwater level measurements were taken. On June 30, all the wells were sampled for groundwater levels as well as chemical and physical characteristics of the water. Parameters were measured with a YSI water quality probe. Due to a heavy rainfall on July 7, not all wells were sampled and measurements were taken with the older Hydrolab H20G probe. The change of the probes restricts the comparability of the results. They should be taken as absolute values with care. Nevertheless, they can be useful for relative comparison.

### *GIS analysis*

Using ArcInfo, a small GIS analysis was done with the gathered data. This included digitizing well locations, building relational data archives and finally analyzing data. Analysis included krieging of data in order to get plots featuring isolines of parameters considered. An attempt to verify data consistency was made with an ArcInfo tool that locates flow accumulation and depressions.

### *Collection and study of recent results*

Because of the short time span of the survey, comparison with older and more thorough studies was essential to get an idea of the results importance and accuracy. A collection of water levels from Olentangy River during the years 1994 to 1997 was taken to put in relation actual river water levels. Recordings of groundwater levels during 1992-1998 showed the magnitude and variations that can occur and again helped to classify the actual measurements.

## Results and Discussion

### *Groundwater Levels*

The average river level at Clinton Park Weir from 1994 to 19 98 was 724 ft above MSL. Measurements made during the actual 1998 survey showed a typical average river water level on June 24 and on July 7 and a flood event on June 30.

The isopleths in Figure 2 show the interpretation of measured groundwater levels. The groundwater surface seems to be dominated by the peak in Well B-3. This well is located in Wetland 2. The missing measurement in Well B-3 on July 7 explains the flat and steady surface according to the isolines in Figure 2c. The question arises as to whether this peak represents the actual surface or is just an artifact resulting from incorrect reference points, a missing well cover or a bad well setup. To answer this question the following arguments should be considered:

1. The wells were placed in the ground before Wetland 1 and 2 were constructed. The construction of the wetlands could have affected the proper placement of B-3. It is questionable if the top of the well casing is still in its original and correctly measured location. A new measurement of the wells' elevation could answer this concern.

2. The peak value at well B-3 is not only seen in the groundwater elevation but also in parameters like

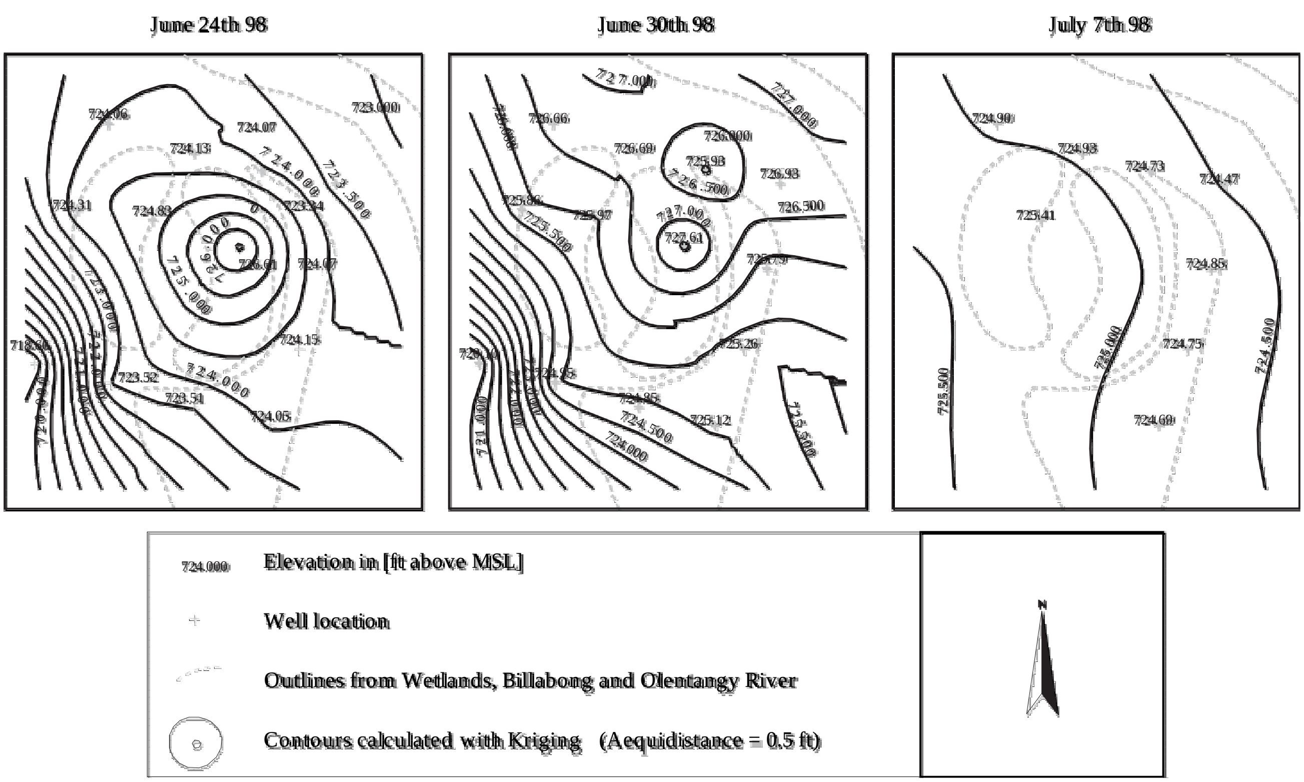



Figure 2. Groudwater elevation (ft above MSL).

conductivity (Fig. 3) and temperature (Fig. 4). This might be a sign that Wetland 2 seepage is influencing the underlying groundwater. A high seepage would result in a higher elevation of the groundwater surface, augmentation of groundwater temperature, and decreasing conductivity. Isoplot results (Figs. 3 and 4) support this hypothesis. According to this hypothesis the seepage rate of Wetland 2 is much higher than the one from Wetland 1. This thesis could be controlled by further research, especially by the calculation of a thorough hydrological budget. Questions about the causes and the origin of these two different seepage rates should also be answered.

3. The values in B-3 might be a consequence of improper well settlement. If the infiltration area of the well pipes is connected with the wetlands water, the water could enter directly into the pipe and modify the results of a groundwater measurement.

4. Local differences might also be the consequence of adjacent soil properties. A cross-section taken along the axis of all wells is shown in Fig. 5. The homogeneous occurrence of silty clay is evidence that the latter thesis cannot fully explain local differences.

To verify data consistency, an analysis of possible flow accumulation was done. Areas in the groundwater surface with divergence or convergence can represent man-made seepage or pumping wells. But they can also be a sign of inconsistent data. Arc/Info allows creation of a cell-based hydrological budget. Results from this analysis showed regions with high flow accumulation and zones with depressions. This puts into question the measurements from the groundwater table. In order to control the measurements the author suggests a re-measurement of all reference levels and an eventual real-world cartographic survey. During this survey the author found inconsistency in well reference point elevations from past years. Furthermore, there are several wells (U-1, U-2, Tr-1, Tr-2, M-1, M-2,...) which have never been referenced to a benchmark.

### *Physical and chemical parameters*

Conductivity, dissolved oxygen, pH, redox-potential and temperature all show spatial distribution that is typical for wetlands. The following paragraph show the general behavior of these parameters and tries to determine causes for measured results.

In general groundwater underneath and in the vicinity of the wetlands is dominated by a higher fraction of near-surface water. The most obvious reason for this is seepage of water out of the wetland. Since water in the wetland is warmed before seepage, the underlying groundwater shows higher temperature than in other regions. Cooler groundwater temperatures along the river suggests that groundwater there seems not to be influenced by a seepage from this section of the Olentangy River (Fig. 4).

Conductivity, as a measure of the amount and valency of ions in the water, is generally lower beneath the wetland. Again, seepage of wetland water leads to this spatial

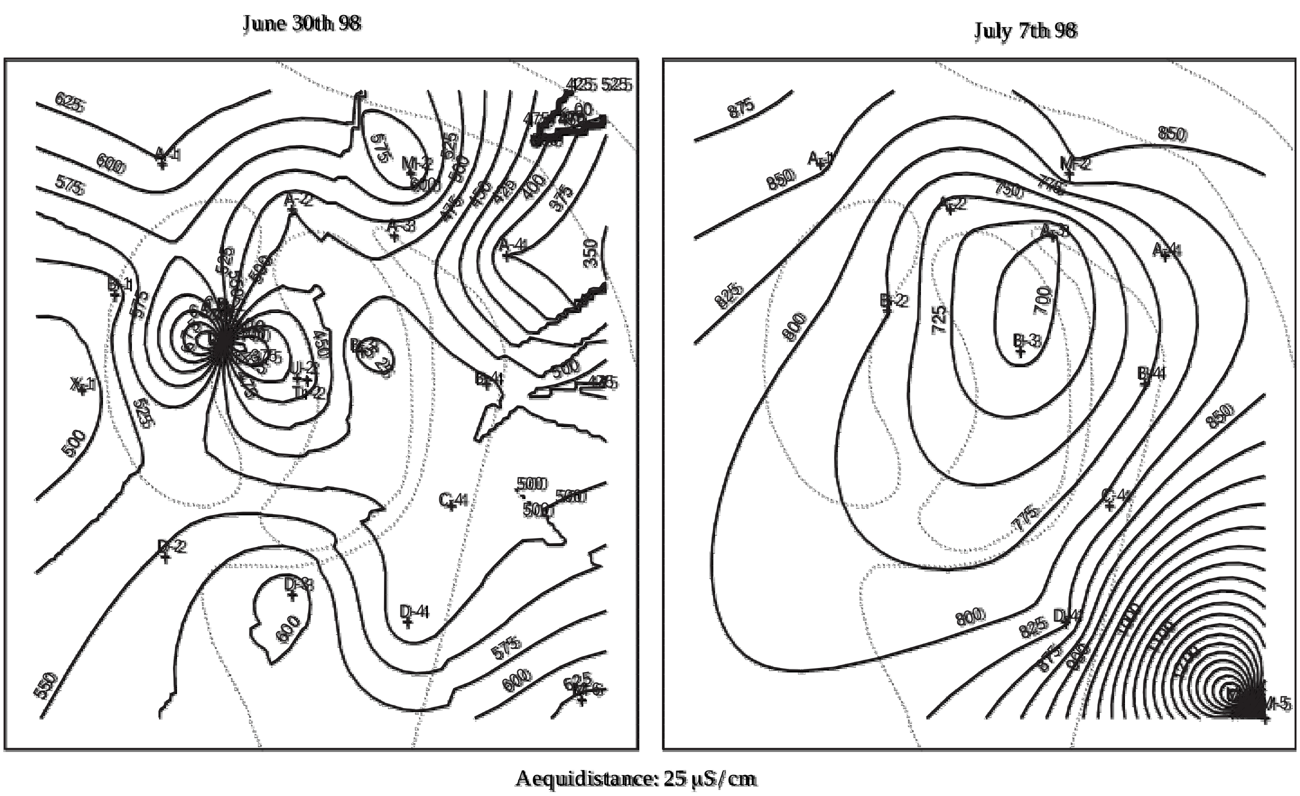
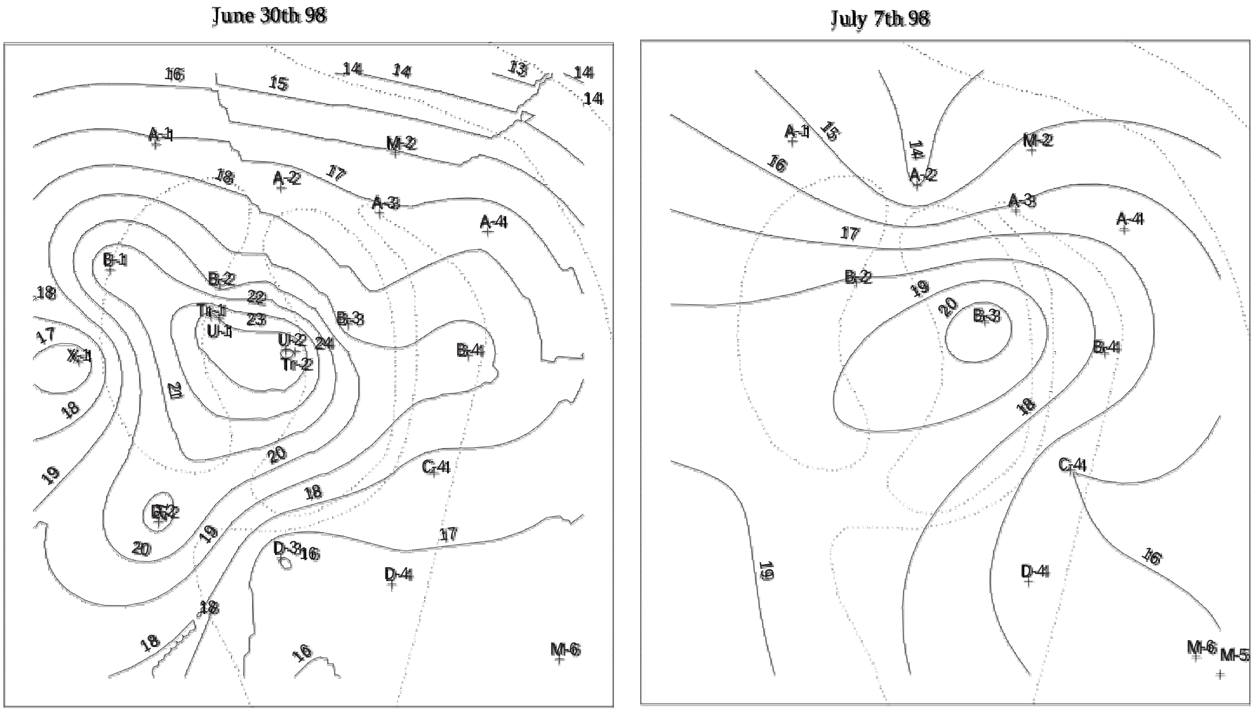



Figure 3. Groundwater conductivity on June 30 and July 7, 1998.

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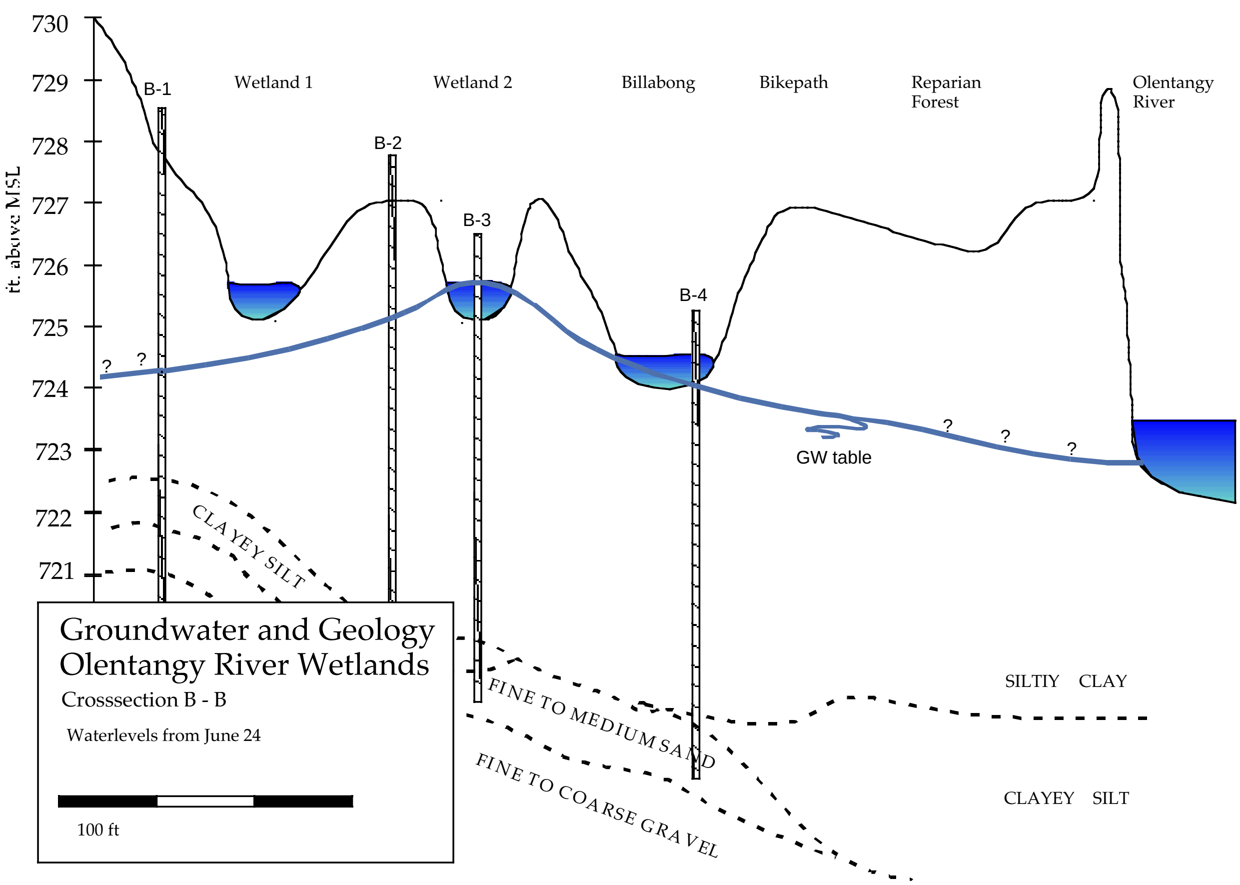


Figure 5. Cross-section of groundwater in the Olentangy Wetland Research Park. Location of cross-section shown in Figure 1.

distribution (Fig. 3).

When surface water enters the soil, its redox potential decreases with the time the groundwater flows beneath the surface (Fig. 6). One factor to get the water reduced is the presence of a carbon source. With this process, oxygen is consumed. The fresh seepage-water from the wetlands, rich in dissolved oxygen from photosynthesis, should increase the groundwater redox-potential and its dissolved oxygen. However the isopleths do not confirm this (Fig. 7). Also one would expect the pH to be higher in regions influenced by wetland water but the measurements did not show any significant changes in pH in the groundwater (Fig. 8).

Care has to be taken when sampling the wells. An undisturbed water column will always show a gradient of the measured parameter in depth direction. The most obvious parameter that shows this effect is oxygen. While the near-surface part is rich with dissolved oxygen, the deeper parts are more anoxic. This fact might be a reason for the unexpected measurements. Although water samples were taken after three void pumpings the representativeness of the final water sample is questionable. In order to confirm these readings more research should be undertaken and an attempt towards a more standardized sample-taking technique should be made.

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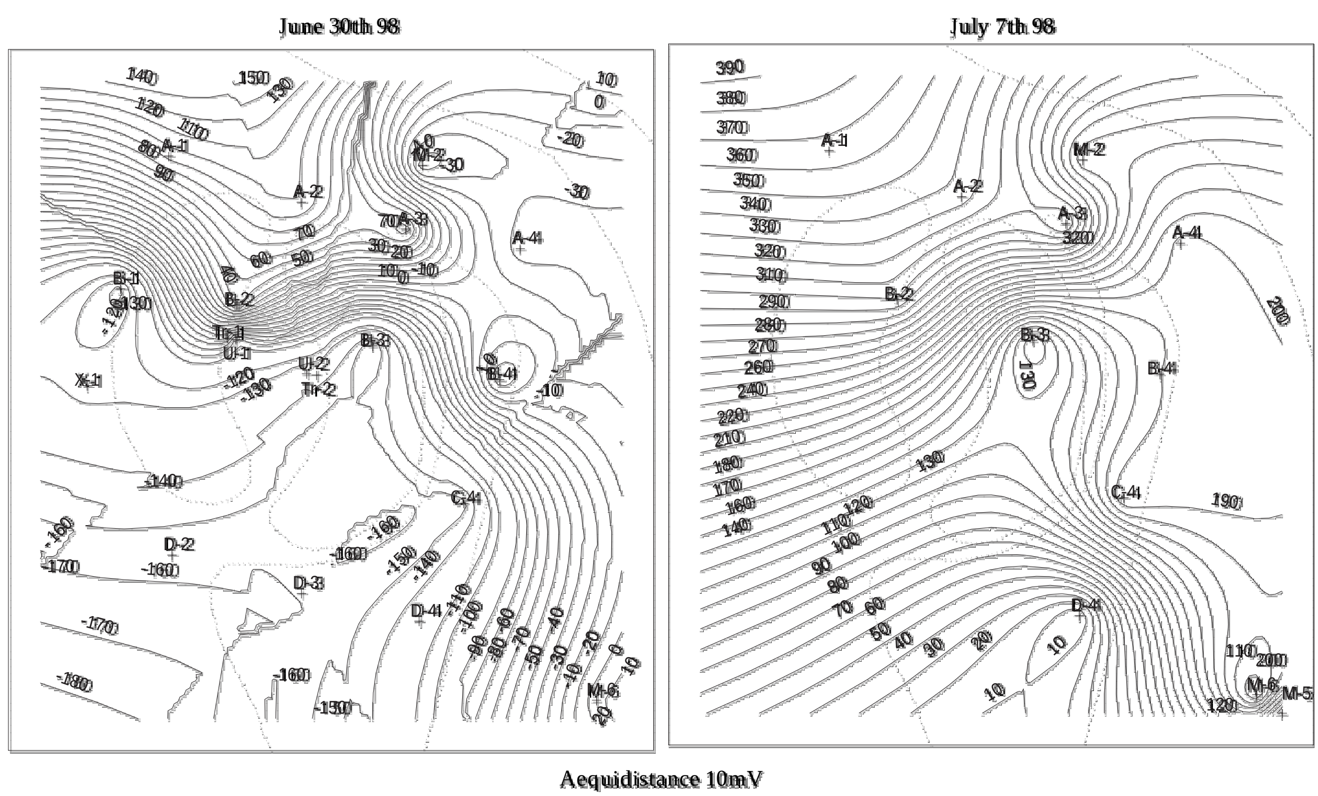


Figure 6. Groundwater redox potential on June 30 and July 7, 1998.

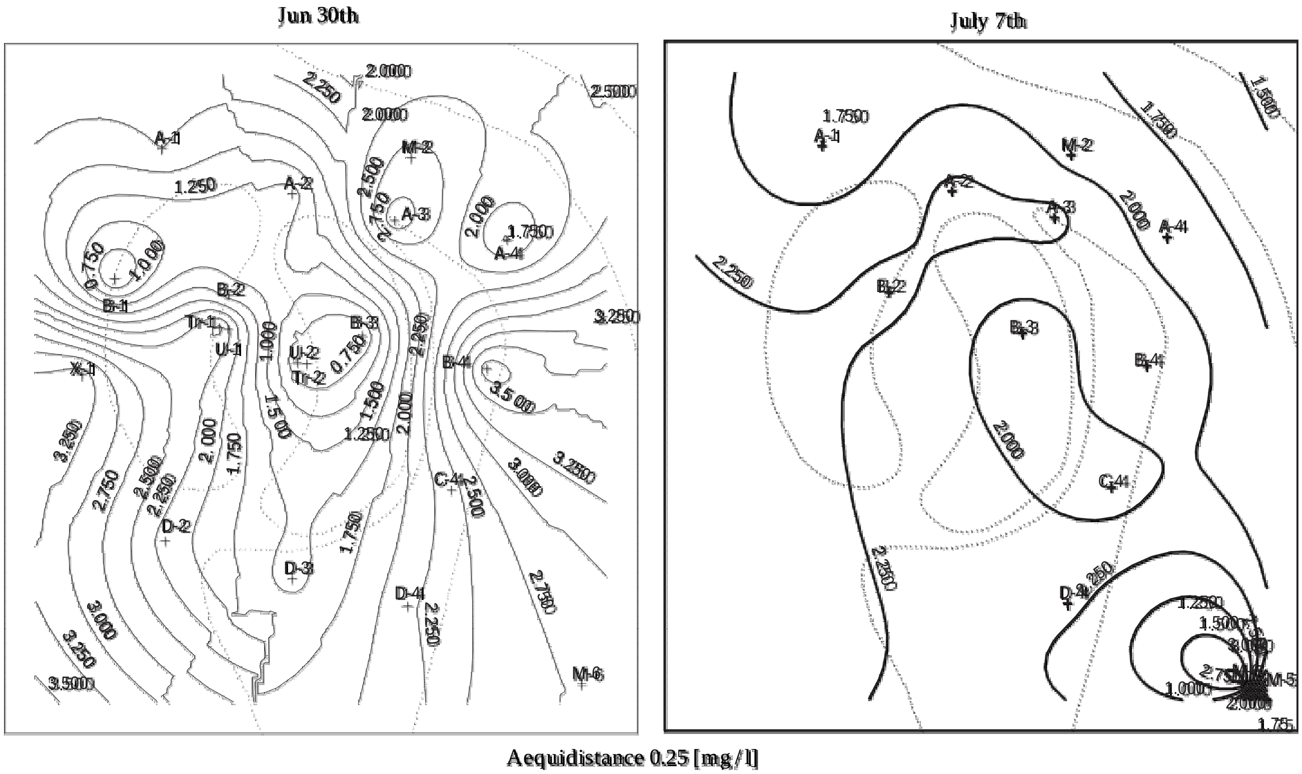


Figure 7. Concentrations of dissolved oxygen in groundwater on June 30 and July 7, 1998.

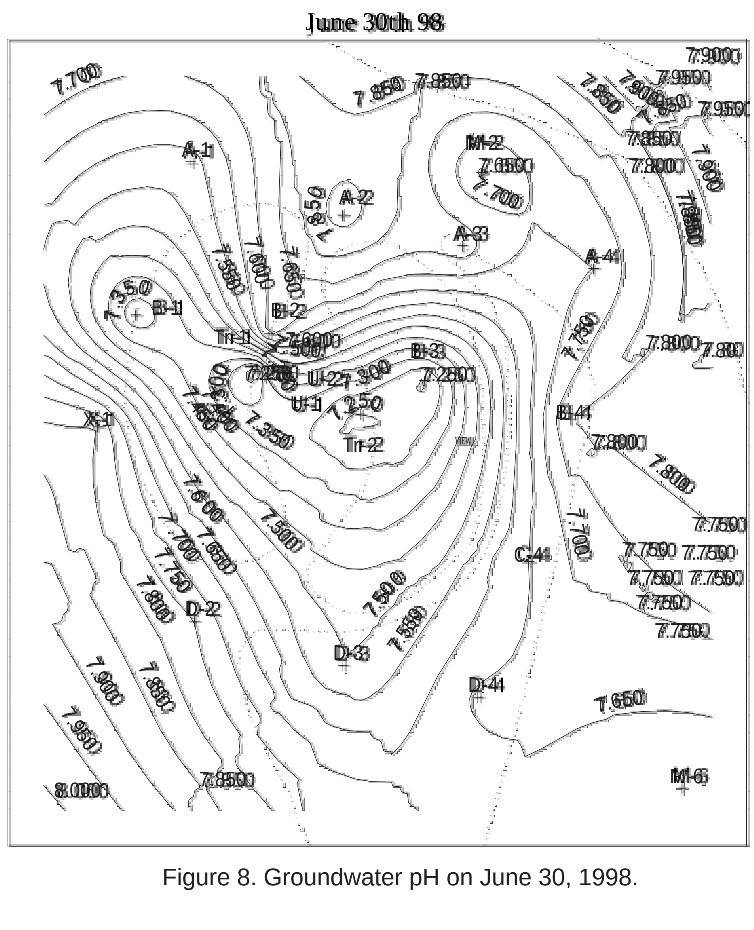


Figure 8. Groundwater pH on June 30, 1998.